

5. Bottom up – methods: Concrete examples



5.0 Recalling Elements of Calculation:

Four steps for calculation

- **step 1:** **unitary gross annual energy savings**
 (per end-use action)
 (+) no. of participants or units
- **step 2:** **total gross annual energy savings**
 (of a facilitating measure)
 (+) double counting, multiplier effect, free rider effect
- **step 3:** **total ESD annual energy savings**
 (of packages of EEI measures)
 (+) timing and lifeline of end-use action within ESD period
 and performance degradation
- **step 4:** **total ESD energy savings for year “i”** (i=2010 or 2016)

5.2 Recalling Elements of Calculation: Three levels of evaluation efforts

	Data scale	Main data sources	Data processing and documenting
Level 1	European default values	existing/available European regulation, studies and statistics	security factor according to the level of reliability of the default value
Level 2	National representative values	up-to-date national statistics, surveys, samples, registries	requirements = minimum set of information and justifications to be reported
Level 3	Program- or Participant-specific	specific monitoring systems, registries, surveys, measurements	requirements to report on the specific data and justifications in detail (standard report at least available)

→ an evaluation method may combine different levels of efforts, as several parameters are needed in the calculations

5.1 Energy audits in industry and tertiary sector

- a method dealing with a type of facilitating measures
- the unit is a participant

(method developed by **Motiva**, Finland
and mainly based on the results of the AUDIT II project)

5.1 Energy audits

- **Step 1.1: Basic calculation formula for the unitary savings**

Annual energy savings of one participant = the participant's energy consumption before the audit – his/her energy consumption after implementation of measures identified in the audit

→ + *distinction between energy carriers: electricity on one hand, (heat + fuels) on the other hand*

- **Step 1.2: General baseline**

→ energy consumption before the implementation of measures identified in the energy audit

5.1 Energy audit

- **Step 1.3: Normalisation factors (e.g., weather conditions, occupancy, plant throughput)**
 - do not apply for savings based on ex-ante calculations (which, however, should use normalised *baseline* data)
 - apply when using ex-post measured data (e.g. temperature corrections for heat consumption)

5.1 Energy audit

- **Step 1.4: Four possible options to calculate unitary annual energy savings (abbrev. as *[savings]*)**

A) [savings] are estimated **from the annual consumption** of a participant or all building m² or m³ audited, using a **default % of savings (Level 1)**

$$[savings] = [\% \text{ of savings} * \text{Annual Consumption (GWh/a)}]$$

B) [savings] are estimated **from the total energy savings potential calculated in the audits**, using a **default % of realised savings (Level 1&3)**

$$[savings] = [\% \text{ of realised savings} * \text{Total Savings Potential (GWh/a)}]$$

C) [savings] are collected **directly through surveys**, ex post, for past but recent energy audit schemes, if option B or D not possible **(Level 2)**

D) [savings] are defined **from the potential** calculated in the audit for implemented end-use actions **(Level 3)**

$$[savings] = [\text{Total Savings Estimated for all Implemented Actions (GWh/a)}]$$

5.1 Energy audit

- **Step 1.4: Option A) = Level 1 (not recommended)**

$$[savings] = [% \text{ of savings} * \text{Annual Consumption (AC)} (GWh/a)]$$

Data needed:

- **EU default value for % of savings**
- **individual AC per participant, or**
(for tertiary) **average specific consumption (per m²)** by building type in the service sector and by energy type (electricity and heat) **AND audit volumes** (**building volumes/floor area** by building type in the tertiary sector)

5.1 Energy audit

- **Proposed EU default value** for the unitary savings for **option A, Level 1: [*% of savings*]**

Sector	Savings as % of annual consumption	
	Electricity	Heat and fuels
Buildings in the municipal services sector (residential buildings not included)	2%	3%
Buildings in the private services sector (residential buildings not included)	1.5%	4%
Industry (energy-intensive process industry not included)	1%	2%

5.1 Energy audit

- **Step 1.4: Option B) = Level 1 and 3 combined**

$[savings] = [% \text{ of realised savings} * \text{Total Savings Potential (TSP)} (GWh/a)]$

Data needed:

- **EU default value for % of realised savings (Level 1)**
- **individual TSP per participant from audit database (Level 3)**

5.1 Energy audit

- **Proposed default value** for the unitary savings for **option B, level 1: [*% of realised savings*]**

Sector	Proportion of realised savings (% , compared to the Total Potential Savings assessed by the audit)			
	Percentages to be used as default value in option B calculations			
	Electricity	Heat and fuels		
Buildings in the municipal services sector (residential buildings not included)	25%	25%		
Buildings in the private services sector (residential buildings not included)	25%	25%		
Industry (energy-intensive process industry not included)	20%	15%		

5.1 Energy audit

- **Step 1.4: Option C) = Level 2**
- **Proposal:** Only to be allowed for past but recent energy audit schemes, if option B or D not possible, i.e., no database of energy savings potentials identified in audits exists;
- Both expensive and rather unreliable

Data needed:

- **Each participants' ex-post achieved annual energy savings due to actions implemented as a consequence of the audit, from a (national) survey**

5.1 Energy audit

- Step 1.4: Option D) = Level 3 (recommended)

$[savings] = [Total\ Savings\ Potential\ of\ all\ Implemented\ Actions\ (GWh/a)]$

Special form:

$[savings] = [Savings\ Potential\ from\ Implemented\ actions + Savings\ Potential\ from\ actions\ Decided\ to\ be\ implemented + a * Savings\ Potential\ from\ actions\ under\ Consideration]$

Data needed:

- Each participants' ex-post data for I, D and C
- participants' ex-ante TSP for each end-use action identified in audit
- default value or national average for a

5.1 Energy audit

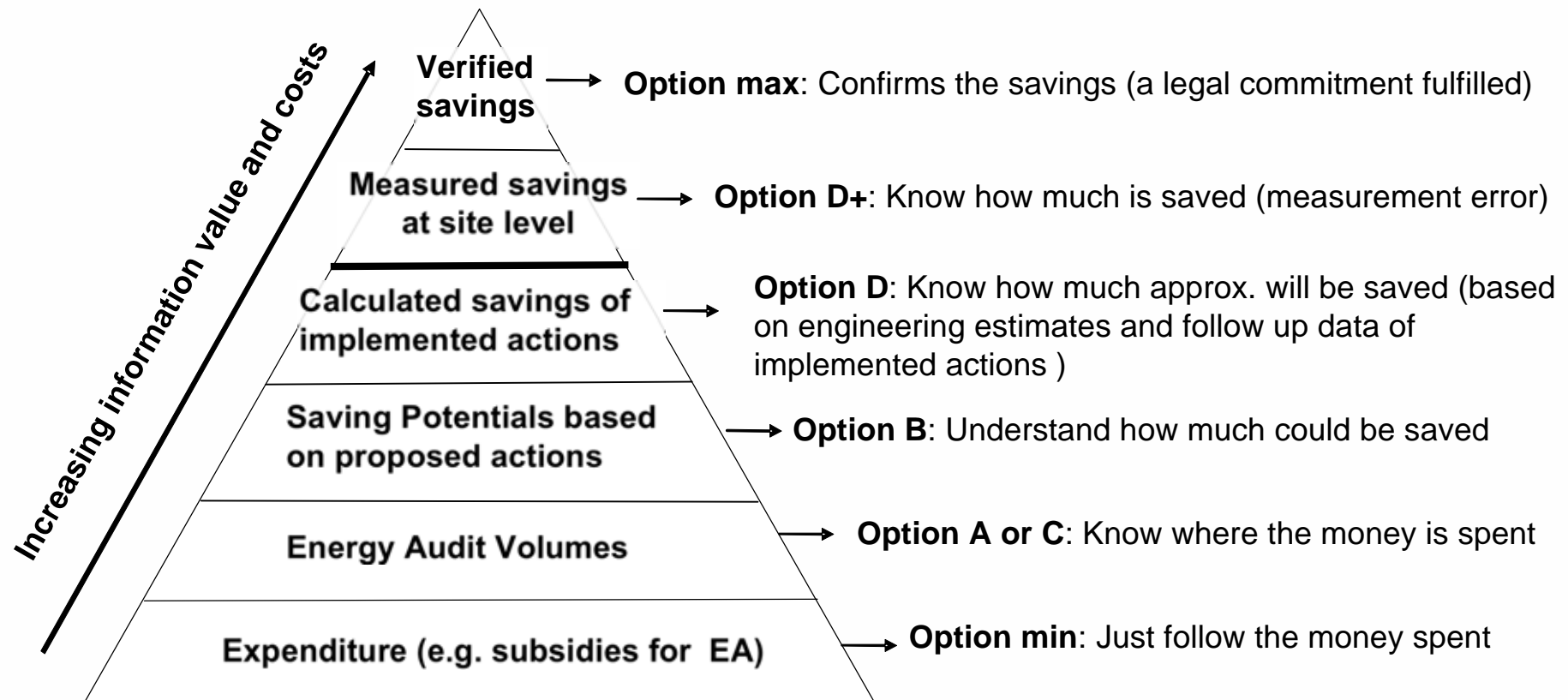
- **Step 2.1: calculation formula for the total gross savings**
→ summing up the savings per participants, making a distinction between industry and tertiary

total gross annual energy savings =

$$\begin{aligned}
 & \sum_{i=1}^n [\text{annual energy savings of } \underline{\text{industrial}} \text{ participant } i] \\
 & + \sum_{j=1}^m [\text{annual energy savings of } \underline{\text{tertiary}} \text{ participant } j]
 \end{aligned}$$

5.1 Energy audit (7a)

■ Step 2.2 Possible monitoring systems



5.1 Energy audit (7b)

■ Corresponding monitoring technique and costs (1)

Options	Coverage	Complexity	Rough cost estimates		Information gained from
			< 100 audits/year	> 100 audits/year	
MIN Expenditure	All audits	Easily achieved	No extra costs	No extra costs	Application
A or C Energy audit volumes	All audits	Easily achieved	Negligible extra costs	Minor extra costs – 0.25 man-months/year	Application
B Saving potentials	All audits	More complex. Tool necessary, i.e. database	Minor extra costs. Need spreadsheet – 0.5 man-month	Development costs: 6 man-months/year Operation costs: 1 man-months/year	Audit report
D Calculated savings of implemented end-use actions	All audits/samples	More complex. Need tool (database) and feedback from clients.	Operating costs in the range of 2 man-months/year	Operating costs in the range of 4 man-months/year	Questionnaire/site visits

5.1 Energy audit (7b)

■ Corresponding monitoring technique and costs (2)

Options	Coverage	Complexity	Rough cost estimates		Information gained from
			< 100 audits/year	> 100 audits/year	
D+ Measured savings at site level	All audits/samples	Complex. Need tool, feedback from clients and analytical expertise.	Costs in the range of 4 man-months/year	Costs in the range of 1 man-year	Questionnaire (annually)
MAX Verified results	Samples	Complex. Need tool, feedback from clients and analytical expertise.	Costs in the range of 6 man-months/year (based on representative samples)	Costs in the range of 1 man-year (based on representative samples)	Monitoring on-site level

5.1 Energy audit

- **Step 3.1: formula for the total ESD savings**

total ESD annual energy savings =

*total gross annual energy savings - **double counting** estimate
- **technical interactions** + **multiplier energy savings** - **free-rider**
savings*

5.1 Energy audit

■ Step 3.2: double counting

- possible crossing with other facilitating measures (e.g. subsidies, voluntary agreement, etc.)
- recommendation: exchanging information between the monitoring systems or reporting savings per end-use action recommended in audit reports instead of per measure

■ Step 3.3: technical interactions

- best addressed **during audit** when estimating the savings potential by **ranking the proposed actions by priority order**, and then using as baseline consumption for the next lower ranked action the consumption taking account of the higher ranked actions

5.1 Energy audit

■ Step 3.4: multiplier effect

- no significant evidence from existing studies
- studies to quantify this effect are costly → recommended to consider this only when multiplier effect is strongly expected

■ Step 3.5: free-rider effect

- a Finnish study assessed it to be 10-15% of the realised actions
 - compensation with multiplier effect in some extent
- may be assumed to be rather limited for energy audits (especially if conservative values are used for savings lifetime)

5.1 Energy audit

■ Step 4: savings lifetime

Level 1	Default values: 6 years for tertiary and 8 years for industry (6 years for all, if no sector distinction can be made from monitored data)
Level 2	Proven national average
Level 3	Lifetime value per type of actions (or group of actions) if: <ul style="list-style-type: none"> - the Member State can present justifying information - values per type of actions are proven (national values) or agreed among Member-States (default EU values)

5.1 Energy audit

■ Choice of the evaluation efforts

- depends on the share of the audit programmes for the national ESD target; a **threshold of 10%** is proposed, above which **at least level 2** values are **required (i.e., option A) excluded**
- depends also on the **data availability** (and hence on the monitoring system used)

5.1 Energy audit

■ Quality assurance / uncertainties

uncertainties can be reduced significantly by **quality assurance** of the audits → if no quality assurance is done, calculations particularly at level 1 are void

when estimated savings exceed a **certain proportion of national** total ESD energy savings **target**, a national **quality assurance** program is **necessary**. It is proposed to set the **threshold** at **5%**.

There are **two factors** to consider:

- 1) the **competence of the auditors**;
- 2) the **quality of the audit reports**.

5.1 Energy audit

- Reporting uncertainties

Level 1	Identify and report sources of uncertainties .
Level 2	Identify and report sources of uncertainties + estimate range of magnitude for each parameter used (min-max)
Level 3	Identify and report sources of uncertainties + conduct a sensitivity analysis with pessimistic/optimistic scenarios or quantify uncertainties (confidence intervals)